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Effect of Polymerized Alkaline Conditioning Fertilizer on Peppers and Disease in Acid Field

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ABSTRACT

Based on conventional fertilization, the effects of different amounts of polymerized alkaline conditioning fertilizer on the prevention and control of pepper disease were studied. The results of the experiment showed that the application of alkaline conditioning fertilizer to peppers had a remarkable effect on growth and development, increasing yield, increasing income and controlling disease. And the effect of applying 2100 kg/hm^2 was the best, of 2625 kg/hm^2 decreased, and of more than 1575 kg/hm^2 was obvious. The yield of applying 2100kg/hm^2 was 58069.7kg/hm^2, and the net benefit was 468325.0 RMB/hm^2. The yield increased by 46.0%, 29.2%, 16.1% and 2.0% respectively compared with treatment 1,2,3 and 5, with significant difference; the net benefit increased by 47.6%, 30.4%, 16.8% and 2.4% respectively. The results are similar to those of the plot tests, and the application rate of the polymerized alkaline conditioning fertilizer is 2,100kg/hm^2. It is suggested that the same area in southern China can be used for reference.

1. Introduction

Lingshan County, Guangxi is located in the south subtropical zone, with good temperature, light, water and heat resources. It is very suitable for developing autumn and winter agriculture. Pepper is the pillar industry of local characteristic economy, and is the important source of farmers' income. However, since autumn and winter peppers cultivation was developed from the 1990s, only one time medium rice and one time autumn and winter peppers have been planted per year, long - term and repeated cultivation has made soil-borne diseases more and more serious. And the soil has been acidic and the effective content of medium elements lacked [1, 2], which seriously inhibited the improvement of pepper yield, quality and benefit. In order to explore the ways to repair the soil environment and optimize the cultivation technology of pepper, the experiment and display comparison of the alkaline conditioning fertilizer applied to pepper were carried out on the basis of conventional fertilization, and the effects of the application on the prevention, control and suppression of pepper's diseases were studied.

2. Materials and Methods

2.1 Basic conditions of test soil

The experiment and demonstration were carried out at the planting base of pepper in Liuxiang Village, Bolao Town, Lingshan County, Guangxi Province. The cultivation system of the base was as follows: each year, only one time medium rice and one time autumn and winter peppers were planted, and the cycle was repeated. The soil is a granitic parent material and periodical water-logging sand mud field, with a soil layer thickness of 20cm. The soil contains organic matter 34.3g/kg, total

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nitrogen (N)1.48g/kg, total phosphorus (P)0.72g/kg, total potassium (K)9.2g/kg, alkalizing nitrogen (N)184mg/kg, available phosphorus (P)46mg/kg, available potassium (K)201mg/kg, available calcium 128mg/kg, available magnesium 31mg/kg, available silicon 422mg/kg, available sulfur 42mg/kg, available boron 0.29mg/kg, and available zinc 0.31mg/kg.PH 5.4; the yield of the preceding rice was 430 kg.

2.2 Test materials

(1) Polymerized alkaline conditioning fertilizer (containing organic matter ≥ 14%, CaO ≥ 26%, MgO ≥ 12%, SiO_2 ≥ 25%, P_2O_5 ≥ 12%, alkaline conditioning active compound, Bacillus subtilis, etc.); (2) Conventional fertilization: farmyard fertilizer 7500kg/hm^2, urea 225kg/hm^2, calcium superphosphate 1125kg/hm^2, compound fertilizer 1125kg/hm^2 (N 18%, P_2O_5 7%, K_2O 20%); (3) Pepper variety: line pepper No. 8; planted on November 3, 2019.

2.3 Test design and method

Five treatments shall be set in the plot test, namely: 1. Conventional fertilization; 2. Conventional fertilization + polymerized alkaline conditioning fertilizer 1050Kg/hm^2; 3. Conventional fertilization + polymerized alkaline conditioning fertilizer 1575kg/hm^2; 4. Conventional fertilization + polymerized alkaline conditioning fertilizer 2100kg/hm^2; 5. Conventional fertilization + polymerized alkaline conditioning fertilizer 2625kg/hm^2. Three repetitions were operated, with each plot 72m^2, and random block was arranged.

Cultivation management: farmyard fertilizer, urea, calcium perphosphate, compound fertilizer, polymerized alkaline conditioning fertilizer as base fertilizer, were sprayed as foliar fertilizer 5 times for each treatment, and other cultivation managements are same. Each plot is 15m long×1.2m wide (including ditch) ×4 qi (a rectangular piece of land in a field, separated by ridges), each of which was 0.9m wide. The planting row spacing 35cm × plant spacing 40cm, and 336 pepper plants were planted in each plot.

The display contrast treatment and cultivation management are the same as the plot test. Each display treatment area is 300m^2 without repetition.

3. Results and Analysis

3.1 Plot test effect

3.1.1 Good effect on pepper character formation

According to the observation and sampling survey in Table 1, 4 treatments with polymerized alkaline conditioning fertilizer had positive effects on the good formation of economic characters. Among them, treatment 4 showed the best, treatment 5 overfertilized, and the effect decreased compared with treatment 4. Compared with each other: the fruit number per plant of treatment 4 increased by 11, 8, 5 and 1 respectively compared with treatment 1, 2, 3 and 5. There was no significant difference in analysis of variance between treatment 4 and treatment 5, but very significant difference between 4 and the others. The single fruit weight of treatment 4 increased by 2.9g, 2.0g, 1.1g and 0.0g respectively compared with 1, 2, 3 and 5, and the difference compared with treatment 1, 2 and 3 was very significant. The fruit length of treatment 4 increased by 5.8cm, 3.0cm, 1.9cm and 0.3cm respectively compared with 1, 2, 3 and 5, and the difference compared with treatment 5 was not significant, but was very significant with the others. The fruit pitch diameter was same between treatment 4 and 5, thicker 0.6cm, 0.3cm and 0.2cm respectively than treatment 1, 2 and 3.

Table 1. Economic Characters of Pepper

Treatment	Number of plants (zone)	Fruit number per plant (pcs)	Single fruit weight (g)	Fruit length (cm)	Fruit pitch diameter (cm)
1	336	40DD	21.5DD	28.2DD	2.0
2	336	43 CC	22.4CC	31.0CC	2.3
3	336	46BB	23.3BB	32.1BB	2.4
4	336	51AA	24.4AA	34.0AA	2.6
5	336	50AA	24.4AA	33.7AA	2.6

Note:15 strains were sampled at fixed point in each plot

3.1.2 Good effect on the prevention and control of pepper disease

After the middle period of pepper growth, the occurrence of pepper disease was investigated once every 10 days and 4 times continuously. The investigation results (see Table 2) showed that only treatment 1 and treatment 2 had umbilical rot, blight, anthracnose, blight, gray mold, scab and bacterial wilt. The average incidence rates of umbilical rot, blight, anthracnose, blight, gray mold, scab and bacterial wilt of treatment 1 were 6.7%, 3.9%, 4.4%, 3.6%, 1.4%, 0.9% and 1.4% respectively. Those of treatment 2 were 0.4%, 0.3%, 0.4%, 0.2%, 0.2%, 0.1% and 0.2%, respectively. The results showed that the application of polymerized alkaline conditioning fertilizer had a good effect on the prevention and control of pepper disease.

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Table 2. Occurrence of Pepper Disease

Treatment	Umbilical rot Plant rate (%)	Blight Plant rate (%)	Anthracnose Plant rate (%)	Blight Plant rate (%)	Grey mould disease Plant rate (%)	Scab disease Plant rate (%)	Bacterial wilt Plant rate (%)
1	6.7	3.9	4.4	3.6	1.4	0.9	1.4
2	0.4	0.3	0.4	0.2	0.2	0.1	0.2
3	-	-	-	-			
4	-	-	-	-			
5	-	-	-	-			

Note: Investigate each treatment plot for an average

Table 3. Pepper Yield Statistic

Treatment	Plot yield				Yield discount (Kg/hm2)	To 1 ratio		With a 4 ratio	
	I	II	III	Average		(Kg)	(%)	(Kg)	(%)
1	288.0	286.5	284.4	286.3EE	39764.1	0.0	0.0	-18305.6	-46.0
2	325.0	323.8	322.0	323.6DD	44944.7	5180.6	13.0	-13125.0	-29.2
3	360.5	361.0	358.8	360.1CC	50014.1	10250.0	25.8	-8055.6	-16.1
4	418.0	417.3	419.0	418.1AA	58069.7	18305.6	46.0	0.0	0.0
5	409.2	408.6	411.9	409.9BB	56930.8	17166.7	43.2	-1138.9	-2.0

3.1.3 Significant increase in pepper production

According to the statistical results of yield in Table 3, the yield increase of treatment 4 was the best, the yield was as high as 58069.7 kg/hm^2. Compared with treatment 1, 2, 3 and 5, the treatment 4 yield increased 18305.6 kg/hm^2, 13125.0 kg/hm^2, 8055.6 kg/hm^2 and 1138.9 kg/hm^2 respectively, with the increase rate 46.0%, 29.2%, 16.1% and 2.0% respectively, and the differences were all very significant. Compared with treatment 4, treatment 5 increased the amount of fertilizer but failed to achieve the desired yield increase, and the yield decreased. From the comparison of yield, it is suitable to control the application amount of polymerized alkaline conditioning fertilizer at 2100 kg/hm^2.

The main reason why the application of polymerized alkaline conditioning fertilizer can increase production and prevent and control diseases is that calcium can neutralize the insoluble organic calcium and soil acid produced by crop metabolism, adjust pH value for crop growth, and supplement the nutrients such as calcium and magnesium to balance the nutrients in the soil, improving the nutritional status and benefit the robust growth of the peppers. Magnesium can enhance the photosynthesis of peppers and play an important role in carbohydrate metabolism, promoting the growth and development of peppers. Silicon can increase the content of soil salt base, promote the decomposition of organic fertilizer and inhibit soil germs. It can make the epidermal cells of crops siliceous and improve the resistance to insect and disease [3-5]. Polymerized alkaline conditioning fertilizer contains Bacillus subtilis, which has the following effects. Firstly, it can inhibit the growth and metabolism of pathogenic microorganisms by producing metabolites at low concentration, thus affecting the survival and activity of pathogenic microorganisms. Secondly, it can induce the resistance of plants and promote the growth of plants by adsorbing the mycelium of pathogenic bacteria to produce lytic substances, resulting in the leakage of protoplasm, causing the mycelium to break, or to produce antibacterial substances, through dissolving the cell walls or cell membranes of pathogenic bacteria spores, causing the perforation and deformity of cell wall to inhibit the spore generation. Thirdly, Bacillus subtilis can produce substances similar to cytokinin and plant growth hormone to promote plant growth and enhance its ability to resist pathogenic bacteria. Fourthly, it can protect the environment; when Bacillus subtilis is combined with organic fertilizer to act on crops or soil, it can colonize the rhizosphere or body of crops, purify and repair the soil, reduce the occurrence of crop diseases and facilitate pepper growth. The combination of organic matter and inorganic fertilizer in the fertilizer has long effect, which is beneficial to the steady growth and increase the yield of pepper.

3.1.4 Obvious increase in peppers' economic benefit

From Table 4, after deduction of fertilizer and labor cost, treatment 4 had the best benefit, and the net benefit of treatment 4 increased 47.6%, 30.4%, 16.8% and 2.4%

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respectively compared with treatment 1, 2, 3 and 5. Treatment 5 increased the amount of fertilizer, but compared with treatment 4, its benefit showed negative effect. The results showed that it was the best when the application rate of polymerized alkaline conditioning fertilizer was 2100kg/hm^2.

3.2 The comparison results displayed

The results of comparative yield (see Table 5) displayed that the yield of treatment 4 was the highest, reaching 57908.0 kg/hm2, and the net benefit was 466,950.5 RMB/hm^2; treatment 4 increased 48.5%, 31.6%, 15.6% and 1.9% respectively compared with treatment 1, 2, 3 and 5, and the net benefit increased 50.2%, 33.0%, 16.2% and 2.3% respectively. The comparison results displayed of the pepper are similar to those of the plot test and have good reproducibility.

4. Conclusion

(1) On the basis of conventional fertilization, the application of polymerized alkaline conditioning fertilizer to peppers obviously promoted the formation of economic characters of peppers, and the effect was the best when the application amount was 2100 kg/hm^2, and decreased when 2625 kg/hm^2.

(2) The application of polymerized alkaline conditioning fertilizer to peppers could obviously promote the increase of yield and income. Among the four application levels, the effect was the best in 2,100 kg/hm^2, decreased in 2,625 kg/hm^2 which was excessive. The yield was 58069.7 kg/hm^2 when 2100 kg/hm^2 was applied, and the net benefit was 468325.0 RMB/hm^2. The yield of treatment 4 was 46.0%, 29.2%, 16.1% and 2.0% higher than those of treatment 1, 2, 3 and 5, respectively, and he net benefits increased 47.6%, 30.4%, 16.8% and 2.4% respectively.

(3) The application of polymerized alkaline conditioning fertilizer had better control and inhibition effect on the occurrence of cord rot, epidemics, anthracnose, blight, gray mold, scab and bacterial wilt of pepper disease, which was beneficial to the robust growth of the peppers.

(4) The comparison results are similar to those of the plot test and have good reproducibility. According to the results of the plot test and demonstration, the effect was best when the application rate of polymerized alkaline conditioning fertilizer was 2100 kg/hm^2. It is suggested that similar areas in the south of China can be used to improve the planting efficiency.

Table 4. Economic Benefit Comparison of Pepper

Treatment	Output value (RMB/hm2)	Adult (RMB/hm2)						Net benefit (RMB/hm2)	With a 4 ratio	
		Mulch	Machine ploughing	Seed	Fat medicine	Picking	Total		(RMB/hm2)	(%)
1	337994.9	1500	1500	1500	15157.5	1000	20657.5	317337.4	-150987.6	-47.6
2	382030.0	1500	1500	1500	17362.5	1000	22862.5	359167.5	-109157.5	-30.4
3	425120.0	1500	1500	1500	18465.0	1100	24065.0	401055.0	-67270.0	-16.8
4	493592.5	1500	1500	1500	19767.5	1200	25267.5	468325.0	0.0	0.0
5	483911.8	1500	1500	1500	20870.0	1200	26370.00	457541.8	-10783.2	-2.4

Note: Farmyard fertilizer is 0.7 RMB/kg, compound fertilizer is 3.0 RMB/kg, urea is 2.2 RMB/kg, phosphate fertilizer is 0.7 RMB/kg, conditioning fertilizer is 2.1 RMB/kg; foliar fertilizer is 1500 RMB/hm2, spraying fertilizer is 2250 RMB/hm2, pesticide and spraying artificial is 1500 RMB/hm2; comprehensive price of pepper is 8.5 RMB/kg.

Table 5. the comparison results displayed

Treatment	Yield	Output value	Total cost	Net benefits	With a 4 ratio	
	(Kg/hm2)	(RMB/hm2)	(RMB/hm2)	(RMB/hm2)	(RMB/hm2)	(%)
1	39001.7	331514.5	20657.5	310857.0	-156093.5	-50.2
2	43998.3	373985.6	22862.5	351123.1	-115827.4	-33.0
3	50101.5	425862.8	24065.0	401797.8	-65152.7	-16.2
4	57908.0	492218.0	25267.5	466950.5	0.0	0.0
5	56801.2	482810.2	26370.0	456440.2	-10510.3	-2.3

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